

## **SECTION 2300**

### **TRENCH EXCAVATION AND BACKFILL**

#### **PART 1 - GENERAL**

##### **1.1 Description**

###### **A. Description of Work**

The work to be performed in accordance with this section includes the excavation, trenching, backfilling and surface repair for all pipelines, pipe culverts, box culverts, accessories and lines connected thereto, complete including sheeting and shoring, dewatering, grading and cleanup.

Excavation for appurtenant structures such as manholes, inlets, transition structures, junction structures, vaults, valve boxes, catch basins, etc. shall be included in this section.

The work shall include the furnishing of all labor, tools, equipment, materials and performing all operations to provide a complete item in accordance with the project plans and these specifications.

###### **B. Related Work Specified Elsewhere**

Earthwork.....	Section 2200
Storm Drain Construction .....	Section 2500
Concrete Culverts.....	Section 2520
Water Line Construction .....	Section 2550
Sewer Line Construction.....	Section 2560
Manhole Construction.....	Section 2570

###### **C. Definitions**

###### **1. Trench**

An excavation in which the depth is greater than the width of the bottom of the trench.

###### **2. Foundation**

Material on which bedding is to be directly placed.

### **3. Bedding**

Granular material on which pipe or structure is to be directly placed. The bedding extends from 6 inches below the pipe to 12 inches above the top of the pipe.

### **4. Select Backfill**

Material placed from top of the bedding to finished subgrade.

## **1.2 Quality Assurance**

### **A. Reference Test Standards and Specifications**

ASTM C94, Ready Mix Concrete.

ASTM C117, Standard Test Method for Materials Finer than No. 200 Sieve by Washing.

ASTM C131, Standard Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

ASTM C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregate.

ASTM D1556, Density of Soil in Place by the Sand-Cone Method.

ASTM D698, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

ASTM D6938-08a, Density of Soil and Soil-Aggregate in Place by Nuclear Methods.

ASTM D6938-08a, Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods.

ASTM D4215, Standard Specification for Cold Mixed, Cold Laid Bituminous Paving Mixture.

ASTM D4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

Rock Correction Procedure for Maximum Density Determination, ARIZ 227.

**B. Frequency of Testing**

**1. Maximum Dry Density and Optimum Moisture Content, ASTM D698.**

- a. One test for each different class or type of material shall be provided by the **CONTRACTOR**.
- b. **CONTRACTOR** shall provide additional test when previous test is suspect, due to subtle changes in the material, as determined by the **OWNER**.

**2. Density of Soil In-Place by Sand Cone or by Nuclear Methods**

- a. **OWNER** will perform a minimum of one test per lift per 500 linear feet of trench for each type of material.
- b. **OWNER** will perform additional tests as required to ensure proper compaction.

**C. Testing Tolerances**

**1. Percent Relative Compaction**

Not less than as specified on plans or in these specifications.

**2. In-Place Moisture Content**

As required to achieve specified percent relative compaction.

**3. Soft or Yielding Surfaces**

Regardless of percent relative compaction obtained by test, areas which are soft and yield under the load of construction equipment are to be removed and replaced at no additional cost.

**1.3 Submittals**

**A. Materials Test Reports**

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1. Report on maximum dry density and optimum moisture content prior to beginning of construction.
2. Report on bedding and backfill materials compliance tests as required.

**B. Spoil Disposal Area**

Provide location and written approval for area to dispose of spoil from operation.

**C. Shoring Plan**

Provide plans, details and calculations by a professional **ENGINEER** registered in the appropriate jurisdiction if shoring or sheeting is required.

**D. Dewatering Plan**

Not required.

**1.4 Job Conditions**

**A. Dewatering**

It is the **CONTRACTOR'S** responsibility to dewater if groundwater is encountered.

**B. Protection of Existing Utilities**

Maintain all utilities both underground and overhead in continuous service throughout the contract period. Liability for damages to, or interruption of services caused by the construction shall be borne by the **CONTRACTOR**.

**PART 2 - MATERIALS**

**2.1 Soil and Soil Aggregate Materials**

**A. Unsuitable materials not to be incorporated in the work include:**

1. Organic matter such as peat, mulch, organic silt or sod.
2. Soils containing expansive clays.
3. Material containing excessive moisture.
4. Poorly graded coarse material.
5. Particle size in excess of 6-inches.
6. Material which will not achieve density and/or bearing requirements.
7. Material containing asphalt concrete or Portland cement concrete.

## **B. Bedding**

Bedding for all water, sewer, storm drain lines, and manholes specified in Sections 2500, 2550, 2560 and 2570 shall be bedded in bedding sand. Concrete culverts, specified in Section 2520, shall be bedded on aggregate base.

### **1. Bedding Sand**

Sandy material, non-plastic and shall conform to the following:

<b>SIEVE SIZES</b>	<b>PERCENTAGE BY WEIGHT PASSING SIEVE</b>
3/8"	100
No. 4	90-100
No. 50	10-40
No. 100	3-20
No. 200	0-15

### **2. Aggregate Base**

Crushed aggregate or processed natural material, clean, hard, sound and free of any detrimental quantity of soft, friable elongated or laminated pieces, organic matter or other deleterious substances. Properties of which shall meet the following requirement:

- a. Grading, ASTM C136 and ASTM C117.

<b>Sieve Size</b>	<b>Percent by Weight Passing</b>
1 1/8"	100
No. 4	38-65
No. 8	25-60
No. 30	10-40
No. 200	3-12

- b.** Percentage of Wear, ASTM C131, maximum percentage of wear of 40 after 500 revolutions.
- c.** Plasticity Index and Liquid Limit, ASTM D4318, maximum plasticity index of 5, maximum liquid limit of 25 percent.

**C. Select Backfill**

Native excavated granular material or approved import material free from unsuitable materials defined herein. Aggregate base may be used as backfill material.

**D. Granular Backfill**

Native excavated or approved import granular material, free draining and free of unsuitable materials defined herein. Granular backfill shall be non-plastic, well graded and meet the following gradation:

<b>Sieve Size</b>	<b>Percent by Weight Passing</b>
1 1/2 inches	100%
No. 200	0-15

**2.2 Portland Cement Concrete**

ASTM C94 and Specification Section 3300.

## **2.3 Asphalt Cement Concrete**

As required in Specification Section 2630.

## **2.4 Cold Mix, Cold Laid Bituminous Paving Mixture**

ASTM D4215.

## **2.5 Buried Warning and Identification Tape**

Polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for locating, warning, and identification of buried utility lines. Provide tape on rolls, 3-inch minimum width, color coded as stated below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing is to be permanent, unaffected by moisture or soil.

<b>WARNING TAPE COLOR CODES</b>	
RED	ELECTRIC
YELLOW	GAS, OIL, DANGEROUS MATERIALS
ORANGE	TELEPHONE AND OTHER COMMUNICATIONS
BLUE	WATER SYSTEMS
GREEN	SEWER SYSTEMS
WHITE	STEAM SYSTEMS

### **A. Warning Tape for Metallic Piping**

Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements indicated above. Minimum thickness of the tape shall be 0.003 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise with a maximum 350 percent elongation.

### **B. Detectable Warning Tape for Non-Metallic Piping**

Polyethylene plastic tape to the width, color, and printing

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requirements indicated above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise.

### **PART 3 - EXECUTION**

#### **3.1 Preliminary Investigation of the Work**

Verify that all of the preliminary work including construction staking has been performed in accordance with the plans and specifications prior to trenching and backfill operations.

#### **3.2 Trenching in Fill Areas**

Grade fill areas to within 1 foot of the finish grade prior to trenching and placement of the pipeline.

#### **3.3 Excavation**

##### **A. General**

Perform all excavations of every description and of whatever substances encountered to the depths indicated on the plans and including excavation ordered by the **OWNER** of compacted fill for the purpose of performing tests. Use open cut excavation methods unless otherwise indicated on the plans or approved by the **OWNER**.



## B. Trench Widths

Excavate trenches for pipe to the following dimensions:

SIZE OF PIPE (I.D.)	MAXIMUM WIDTH AT TOP OF PIPE GREATER THAN O.D. OF PIPE	MINIMUM WIDTH AT SPRINGLINE EACH SIDE OF PIPE
Less than 18"	16"	6"
18" to 24" inclusive	19"	7 ½"
27" to 39" inclusive	22"	9"
42" to 60" inclusive	½ O.D.	12"
over 60"	36"	12"

Maintain trench walls as vertical as possible except as required by safety standards and as required for sheeting and shoring.

If the maximum trench width is exceeded at the top of the pipe, the **CONTRACTOR** shall provide necessary additional load bearing capacity by means approved by the **OWNER** at no additional cost to the **OWNER**.

## C. Overexcavation

### 1. Unauthorized Overexcavation

Fill and compact unauthorized excavation beyond the specified grade line, at the **CONTRACTOR'S** expense, with bedding material, compact to 95 percent of the maximum density. No payment will be made for unauthorized overexcavation.

### 2. Rock

Overexcavate rock encountered in the trench to provide a minimum of six inches of bedding below the pipe and the minimum width at the springline.

### **3. Unsuitable Material**

Overexcavate unsuitable material to the depth necessary to provide the required support as determined by the **OWNER**. Backfill the overexcavation with bedding material and compact to at least 95 percent of the maximum density.

#### **D. Excavation for Manholes, Valves, Inlets, Catch Basins and Other Accessories**

Provided the excavated surfaces are firm and unyielding, the **CONTRACTOR** may elect to cast concrete for the structure directly against excavated surfaces. Overexcavate to provide bedding where shown on the plans.

#### **E. Pavement and Concrete Cutting and Removal**

Sawcut, remove and dispose of existing pavements and concrete per Specification Section 2110.

#### **F. Grading and Stockpiling**

##### **1. Grading**

Grade in the vicinity of the trench to prevent surface water from flowing into the trench. Remove any water accumulated in the trench by pumping or by other approved methods. Stockpile excavated material in an orderly manner a sufficient distance back from the edges of the trench to avoid overloading and to prevent slides or cave-ins.

##### **2. Topsoil**

Excavate topsoil and stockpile separately. Replace topsoil upon completion of backfill and grade to the elevations indicated on the plans.

#### **G. Shoring and Sheet piling**

Shore, sheet and brace excavations as set forth in the rules, orders and regulations of the United States Department of Labor Occupational Health and Safety Administration (OSHA). Provide detailed plan and calculations as prepared by a registered professional **ENGINEER** for excavations 20 feet in depth or greater or when

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shoring, sheeting or bracing deviates from OSHA standards. Place and remove shoring, sheeting and bracing so as not to damage adjacent improvements, utilities or utility being placed. Costs for shoring, sheeting and bracing to be incidental to the pipe item.

## **H. Open Trench**

### **1. Maximum Length**

The maximum length of open trench at any one location is not to exceed 500 feet, provided that all proper barricades and safety procedures have been addressed. The trench is considered to be open until backfill is completed to adjacent finish grade elevation.

### **2. Street Crossing**

Complete backfill of trench across streets at the end of each work day. Use temporary patch material (cold mix asphalt concrete) or steel plates as required.

### **3. Temporary Provisions**

Furnish and install trench bracing and steel plating required to provide safe and convenient vehicular and pedestrian passage across trenches where required. Maintain access to and from emergency facilities at all times.

## **3.4 Foundation, Bedding, Backfilling and Compaction**

### **A. Foundation**

Excavate trench bottom to the depth and width as shown. Remove all loose, disturbed material from the bottom of the trench such that the bedding shall rest on firm, undisturbed soil.

### **B. Bedding**

Moisture condition and place bedding material to required thickness. Compact bedding material to the specified density.

### **C. Fine Grading**

Accurately grade the bottom of the trench to provide uniform bearing

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and support for each section of pipe at every point along its entire length, except where it is necessary to excavate for joints.

**D. Moisture Conditioning**

Moisture condition all bedding and backfill materials by aerating or wetting to obtain the moisture content required to achieve specified percent relative compaction. Completely mix the material until the moisture content is uniform throughout the lift.

**E. Lift Thickness**

1. The following table applies when using mechanical compaction:

<b>LIFT DESCRIPTION</b>	<b>MAXIMUM LOOSE LIFT THICKNESS, INCHES</b>
Initial Bedding	8
Bedding	1/3 Pipe Diameter, or 8 inches, whichever is less
Backfill	8
Aggregate Base Surfacing	6

Lift thickness may be increased if **CONTRACTOR** can prove, through a series of density tests, that minimum density is achieved throughout the lift thickness.

2. Where water jetting is used, bedding for conduits, 24 inches or less in I.D., may be placed in one lift. For larger conduits the first lift shall not exceed the springline of the pipe. Backfill will be placed in lifts as required in the following table prior to settlement.

<b>TRENCH WIDTH</b>	<b>BACKFILL LIFTS</b>
18" to 24"	Not to exceed 4'
25" to 36"	Not to exceed 6'
Over 36"	Not to exceed 8'

## **F. Compaction**

### **1. Compaction Methods**

Construction shall be accomplished by water jetting or mechanical methods. Rubber tire wheel rolling will not be allowed.

### **2. Pipe Haunch**

When using mechanical methods, hand compact initial backfill in pipe haunch with a pipe haunch compactor (J-bar) or mechanical vibrator sized to fit the narrow width between the pipe and the trench. Give special attention to provide proper compactive effort in the pipe haunch zone.

### **3. Water Jetting**

Water consolidation by jetting shall be accomplished with a 1-1/2" pipe of sufficient length to reach the bottom of the lift being settled with adequate hose attached and a water pressure of not less than 30 psi. All jetting shall be accomplished transversely across the trench at intervals of not more than 6 feet with the jetting locations on one side of the trench offset to the jetting locations on the other side of the trench. The entire lift shall be leveled and completely saturated working from the top to the bottom.

The **CONTRACTOR** shall be entirely responsible for establishing each lift depth so as to avoid floating the conduit being placed and shall make any repair or replacement at no cost to the **OWNER**. However, for conduit larger than 24 inches I.D., the first lift shall not exceed the springline of the conduit.

Flooding is not acceptable as a water consolidation method unless authorized in the specification or by a written change order. It will consist of the inundation of the entire lift with water and then puddled with poles or bars to ensure saturation of the entire lift.

Where jetting or flooding is utilized and the surrounding material is such that it does not permit proper drainage, the **CONTRACTOR** shall provide, at his expense a sump and a pump at the downstream end to remove the accumulated water.

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The use of water consolidation does not relieve the **CONTRACTOR** from the responsibility to make his own determination that such methods will not result in damage to existing improvements. The **CONTRACTOR** shall be responsible for any damage incurred.

Where water consolidation is not permitted or does not result in adequate compaction, the backfill material shall be compacted with hand and/or mechanical work methods using equipment such as rollers, pneumatic tamps, hydro-hammers or other approved devices which secure uniform and required density without injury to the pipe or related structures.

Water consolidation will not be permitted for non-granular material.

#### 4. Compaction Densities

Thoroughly compact trench bedding and backfill to not less than the percent relative compaction as presented in the following table, unless more stringent requirements are called for on the plans.

PERCENT RELATIVE COMPACTION MINIMUM DENSITY REQUIRED				
Backfill Type	Location	From Subgrade Surface To 2' Below Surface	From 2' Below Surface To 1' Above Top of Pipe	From 1' Above Top of Pipe To Bottom of Trench
I	Under any existing or proposed pavement, curb, gutter, sidewalk, or such construction included in the contract or when any part of the trench excavation is within 2' of the above.	100% for granular  95% for non-granular	95%	95%
II	On any utility easement, street, road or alley right-of-way outside of (I).	95%	95%	95%
III	Around any structures or exposed utilities.	95% in all cases		

#### 3.5 Buried Warning and Identification Tape

Place warning and identification tape to the depth indicated on the plan. Center tape over pipeline.

### **3.6 Backfill for Manholes, Valves, Inlets, Catch Basins and Other Accessories**

Backfill appurtenances and structures including bedding, backfill, lift thicknesses and compaction as indicated in the adjacent trench detail.

### **3.7 Pavement Replacement and Surface Restoration**

#### **A. Grading**

Perform all grading adjacent to backfilled trenches and structures necessary to leave the area in a neat and satisfactory condition as approved by the **OWNER**.

#### **B. Surface Restoration**

Restore all streets, alleys, driveways, sidewalks, curbs or other surfaces which were broken into or damaged by the installation of the new work to a condition as good as or better than originally encountered in accordance with these specifications, accepted standards and as acceptable to the property **OWNER**.

##### **1. Landscape**

Replace landscape rock, sod, shrubs, trees, grass, sprinkler systems as required to a condition as good as or better than originally encountered in accordance with these specifications, accepted standards and as acceptable to the property **OWNER**.

##### **2. Temporary Pavement**

Place cold mix, cold laid bituminous paving mixture in accordance with ASTM D4215 immediately following backfilling and compaction of trenches through existing pavement. Maintain pavement in safe and smooth condition until final pavement can be placed. Place final pavement within seven (7) days after original pavement was removed.

##### **3. Pavement Replacement**

Replace permanent asphalt cement, concrete pavement per the requirements of Specification Section 2630, Asphalt Concrete Pavement.

#### **4. Clean Up**

Remove all excess soil, concrete, etc. from the premises.  
Leave job site in a neat and clean condition.

### **PART 4 - MEASUREMENT AND PAYMENT**

#### **4.1 Measurement**

##### **A. Trench Excavation and Backfill**

No measurement will be made for trench excavation and backfill.

##### **B. Overexcavation**

Overexcavation of unsuitable material will be measured by the average end area method per Section 2200, Earthwork.

##### **C. Surface Repair**

Measure surface repair along the centerline of utility over which it occurs from junction center to center.

#### **4.2 Payment**

##### **A. Trench Excavation and Backfill**

No payment will be made for trench excavation and backfill. All trench excavation and backfill work including but not limited to excavation, material testing, disposal, backfill grading is incidental to the pipelines and appurtenant bid items.

##### **B. Overexcavation**

Payment for overexcavation will be made per Specification Section 2200, Earthwork.

##### **C. Asphalt Concrete, Trench Surface Repair**

All costs for furnishing and installing asphalt concrete trench surface repair including Aggregate Base, tack coat for edges, subgrade preparation, compaction will be included in the unit price bid per linear foot for **ASPHALT CONCRETE TRENCH SURFACE REPAIR**. The unit price shall be considered as full payment for constructing the



pavement repair section as required including placement of base aggregate and pavement. No compensation shall be made for pavement repair required due to pavement damage caused during pipe installation. The length of surface repair will be measured along the centerline of the pipe from pavement edge to pavement edge.

Any additional pavement patching required for removal of existing structures, location of lines, or any damage done by the **CONTRACTOR** shall be considered incidental to the appropriate Bid Items.

See Section 00310 Bid Schedule for Bid Items.